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REPORT ON

Sewer System and Water Supply

FOR THE

City of Winnipeg, Manitoba

BY

PROF. ALLAN HAZEN
of New York, N. Y.

February, 1905

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Prof. Hazen's Report.

To His Worship the Mayor and the Council of the City of Winnipeg.

GENTLEMEN:

In accordance with instructions received from Mayor Sharpe, I have examined the sewers, and the sources of the water supply of the city of Winnipeg, and beg to present the following report upon these matters, particularly as bearing upon the recent outbreak of typhoid fever, and the means to be taken to prevent a recurrence of it.

Prof. Edwin O. Jordan has recently examined and reported upon the causes of typhoid fever in Winnipeg. We met Prof. Jordan in Chicago, and talked with him at length regarding the matter. I have also met your health officer, Dr. Douglas, and have discussed many phases of the situation with him. Prof. Jordan's report is clear and full, and is to be taken as authoritative upon the causes of the fever. I shall confine myself to a consideration of the conditions which have been mentioned in connection with the fever, and of which modifications may be desirable.

SEWERS—

Your City Engineer, Col. H. N. Ruttan, has given me every facility for investigating the sewers, and all conditions relating to them. The sewers of Winnipeg are built on the combined system, that is to say, they remove both the house sewage and the rain water. They are capable of carrying about one-fourth an inch of run off per hour from the area served. The original design of the sewer system was well considered, and it has been wisely and consistently carried out and extended. In the sewers now being built the best modern methods are being used.

Winnipeg is flat, and not very high above the flood height of the rivers. There is some difficulty in designing sewers low enough at the extremities to sufficiently drain the adjoining ground, and at the same time with sufficient inclination to produce a fair velocity of flow, and to discharge into the river at an elevation high enough to prevent too much flooding and back water when the river is in flood. From the profiles of the main sewers which I have seen, I think the design is all that could be reasonably secured under the existing conditions in this respect.

The sewers are designed with inclinations to produce enough velocity to prevent the forming of deposits. The computations of velocity are on the assumption that certain quantities of water flow in the sewers. As a matter of fact the actual flows are often less than the quantities assumed in making the design, and consequently the actual velocities are less than the assumed velocities, and the likelihood of deposits is increased. Usually this is a matter of little importance, because the rains occuring at intervals furnish quantities of water which flush out the sewers, and restore them to their original condition. In Winnipeg the conditions are different, in that for a very considerable proportion of each year, there are no rains, and even the winter thaws which melt the snow, thus furnishing water, are almost unknown. There is therefore a considerable period each year, when no natural flushing takes place, and flush tanks or other artificial means must be used to keep the sewers in good condition. In this respect the conditions are quite different from those in cities farther south.

Ventilation of Sewers.

There are various ways of ventilating sewers. In nearly all cities the manhole covers are perforated to allow circulation of air. In many cities the catch-basins are made in such a way as to allow air to pass through them. In other words they are not trapped. In a considerable number of cities, including Montreal, Minneapolis and St. Paul, no traps are used upon the house drains, and in this case air is able to pass freely through such drains and through the soil pipes in the houses, escaping above the roofs of the houses. Where this is done, the air in the sewer finds its way through the highest outlets, namely, through the soil pipes, and there is a down draft through the perforated manhole covers in the streets.

In Winnipeg, all the inlets and all the house drains are trapped, and it is also necessary, on account of the cold climate, to put straw in the mouths of the sewers to prevent freezing, thereby shutting off this source of ventilation. The sewers are thus ventilated exclusively through the perforated covers of the manholes in the streets and in the absence of natural flushing, and with rather flat grades, which are unavoidable in a perfectly flat city, it is not surprising that odors are produced, and discharged from the manholes which at times are very disagreeable.

There is plenty of precedent for the use of traps. They are required in New York, Boston, Toronto, and many, if not most American cities. It is understood they are generally used in England but not in Germany. Colonel Ruttan has collected a large amount of information as to the use of traps in American cities. He has also an abstract of some of the most important reasons for using and for not using traps. He has also investigated the plumbing in a considerable number of houses in Winnipeg with the general result of finding that the plumbing is not associated with typhoid fever. In fact his statistics show a somewhat larger proportion of cases of typhoid fever in the houses where the plumbing is good, than in those where it is defective.

It was formerly thought that infectious diseases could be carried from one person to another, and from one house to another by the air of sewers. This idea was based upon conjecture rather than upon evidence. But as long as the matter was in doubt, the only safe course was to assume that disease might be so carried. The use of the trap thus seemed necessary.

But after many years of experience and long continued investigation there is not the slightest reason to believe that infectious diseases are carried by the air of sewers. The men employed to clean the sewers and to care for sewage disposal works are free from this infection, even when the disease is prevalent in the houses entering the sewers. Disease is often carried by sewage, but not by the air of sewers.

Illuminating gas often enters sewers from leaky gas mains and gives rise to odors and other troubles, but this is an entirely different matter from the transfer of infection.

The belief is now firmly held that infectious diseases are not carried by the air of sewers, and, this being so, the chief reason for the use of the trap on house connections falls to the ground, and the reasons for not using it out-weigh the reasons for using it.

It has been thought by many that the odors from the sewers in Winnipeg had to do with the typhoid fever. I agree fully with Prof. Jordan on this, and I wish to state most emphatically that the odors have nothing whatever to do with the typhoid fever. Nevertheless they are disagreeable and should be done away with.

The most effective way of preventing odors from the man-holes is to abolish the traps upon the house drains, or at least a part of them. I say a part of them, because a small proportion of the whole number of connection would serve to ventilate the sewers, and if the use of traps were made optional, instead of compulsory, as in St. Paul, it is probable that in a short time a sufficient number would be without traps to ventilate the sewers and do away with the present nuisance in the streets. It would not be necessary to require anyone to do away with his trap, who had a personal preference for it.

If the traps are done away with, there are two other matters which must be attended to, and which are both very important.

The first is:—That the plumbing in each house in which the trap is omitted must be perfectly tight, and must be so kept. The inspection of plumbing should be frequent and thorough. It will be necessary to re-organize the plumbing inspection service to do this properly.

The second is :—That means must be taken to prevent the soil pipes from freezing above the roofs. In St. Paul it is found sufficient to enlarge the soil pipe at the top, so that a considerable amount of frost can accumulate in the enlarged end of it without obstructing the passage of air. In Minneapolis a galvanized iron jacket is required about the pipe above the roof, leaving an air space. This arrangement is perhaps better adapted to the climate of Winnipeg, but whatever means is adopted must be such as to insure at all times a free passage for the air.

If these precautions are followed, there is no sanitary objection to the removal of the traps.

Experience in the cities mentioned, and in many others indicates that it is possible to so control these conditions, that no harm will follow the omission of the house traps.

I recommend that this course be followed in Winnipeg, that is, that the use of the house trap be made optional, but coupled with stringent regulations covering the conditions necessary to success without the trap. This will have the effect of removing the disagreeable smells from the middle of the streets. The foul smelling air will then escape above the tops of the houses where it will be unnoticed.

On the Discharge of Sewage.

Sewage is now discharged as is nearest and most convenient to either the Assiniboine or the Red River. If the conditions are otherwise equal, it is obviously better to have the outlets discharge into the Red River at as low a point as possible.

It is not worth while to incur a large expense to secure this result, however. The Assiniboine cannot be used as a source of water supply below any point where the sewers for Winnipeg will be constructed. The minimum flow of the river, which Col. Ruttan tells me is about 600 cubic ft. per second, is so great that it will receive and dilute so as not to produce a nuisance the sewage from a population of at least 150,000. When the quantity of sewage draining that way exceeds this amount and when the condition of the Assiniboine River becomes objectionable, it will be necessary to construct an intercepting sewer to carry the dry weather flow of sewage to the Red river below the city. Such an intercepting sewer was contemplated in the original design, but it will not need to be built for a very long time.

The only further recommendation that I have to make regarding the sewers, is that contained in Prof. Jordan's report, namely, that the houses in the city be connected with them as rapidly as possible. From the standpoint of typhoid fever, it is a vital matter, that these connections should be made.

It should also be stated that when the number of connections is larger, and when the quantity of water used in the city is greater, it will tend to keep the sewers in better condition, and to reduce the odors now rising from the manhole covers. And this would be true even though traps should continue to be used on all connections.

Water Supply.

An adequate supply of water is one of the first essentials to a satisfactory sanitary condition. The present water supply of Winnipeg is taken from a well in the limestone rock. The water is softened before being pumped to the city. From a Hygenic standpoint the quality of the water is all that could be desired. The quantity of water is not now sufficient to meet the needs of the city, and it seems that it has been inadequate in quantity for some years. An additional well has been dug and another pump will be ready for service at an early date. These additions will materially add to the quantity of water available. It can hardly be hoped however, that they will suffice for more than a very short period. The city will be doing very well if the supply last until a new supply can be obtained, even if the new supply is undertaken at the earliest possible moment.

The general arrangement of the supply and the successful installation of a softening plant are particularly creditable to the city, and to all who have had to do with them, and the present inadequacy of the works is due to the extraordinary and unexpected growth of the city, and not to failure to make ordinary allowances for growth.

The Assiniboine Pumping Station.

The city was formally supplied by a private company with water from the Assiniboine river. The pumping station was taken by the city with the rest of the plant. Because sufficient water was not available from the new source, it has been necessary from time to time to use water from the Assiniboine river. Until recently this only happened in case of a large fire. At the present time it must be used to a limited extent very frequently in order to maintain the supply.

The water after pumping passes through five pressure filters, each with a filtering area of 73 square feet. If the filters were in good order, and were provided with proper coagulating and settling devices, it would be possible to purify to a reasonable degree one million gallons of water per day. The filters are not in very good order, however, and the auxiliary apparatus necessary for efficient work is not at hand. A temporary coagulating arrangement has been installed since my arrival in Winnipeg, but even with it, it is not possible to purify the water sufficiently. From a sanitary standpoint the treatment of the water is not satisfactory.

Under the present conditions, the use of this pumping station is unavoidable, but it will be absolutely necessary to discontinue it at a very early date. It will be necessary to shut down this station before the first thaw in the spring, because the night soil from the privies in the city is placed where it will drain to the river above the pumping station. Under the conditions which have prevailed in Winnipeg, this material is full of infectious matter. It is now frozen hard and is harmless, but the first thaw in the spring will take some of it to the Assiniboine river, and the use of the water at that time might and probably would be disastrous.

It will also be necessary to permanently do away with this station at an early date, because a sewer is now being built which will discharge into the river above it. The use of this pumping station when the new sewer is put in service is not to be thought of. It is thus apparent that the use of Assiniboine water at the present pumping station is now unsatisfactory, and the city will very soon have to depend entirely upon well water.

The Future Water Supply for Winnipeg.

An exhaustive report on this subject was made by Mr. Rudolph Hering eight years ago. The subject was fully considered, and the conclusions reached are as applicable today as they were then, with one exception, namely, the population and the required size of works. In eight years Winnipeg has grown at a rate far beyond that which was anticipated by Mr. Hering. The population has more than doubled; the number of water services has increased four and a half times, and the quantity of water which must now be provided, and which is requred by the growth of the city is correspondingly greater. I think the figures used by Mr. Hering must be multiplied by at least two and a half throughout to make them applicable to present conditions.

The growth of the city during the last four years is shown in the following table:—

	Jan. 1. 1901.	Jan. 1. 1902.	Jan. 1. 1903.	Jan. 1. 1904.	Jan. 1. 1905.
Number of houses in Winnipeg	7,426	7,951	8,719	10,087	12,140
Number supplied with water	....	2,600	3,300	4,800	7,000
Number not supplied with water	....	5,351	5,419	5,284	5,140
Average consumption of water in gallons per day, taken from plotting of annual average figures	....	1,520,000	1,610,000	1,830,000	2,160,000
Gallons daily per service	....	583	486	381	308
Assumed average number of persons per house	5.5	5.6	5.8	6.0	6.3
Gallons daily per person in houses connected	....	104	84	64	49
Estimated population	41,000	44,500	50,500	61,000	77,000

There is reason to believe that the actual population is considerably larger than that computed above. So far as this is the case, the reason for the immediate installation of a large additional supply is greater.

On the Quantity of Water to be Provided.

From this table it appears that the quantity of water now supplied is 49 gallons to each person using it, without deduction for the water used for public and manufacturing purposes. The amount of water allowed at the minimum rate at present is 20 gallons per room or approximately 20 gallons per capita, but it must be remembered that the quantity of water which must be pumped when all the services are metered is very largely in excess of that accounted for by the meters. It seldom happens that more than 50 per cent. of the whole amount of water pumped is accounted for. This is owing to unavoidable leakages, and the under-registration of meters.

The amount of water used recently in Winnipeg when rather stringent measures have been necessary to k[illegible] down the consumption, cannot be taken as a safe guide in estimating [illegible]ture requirements. I believe that on an average 50 gallons daily per capita is as low a figure as should be used for domestic requirements, and in addition to this I add 10 gallons for railroad and manufacturing purposes, making 60 gallons in all. At present water is not supplied to the railroads, and, but little for manufacturing purposes, but the city should be in a position to meet reasonable demands of this kind.

The sixty gallons per capita daily is an average for the year. During some months and especially during some weeks, the consumption will be above the average. The maximum weekly use will probably be at least 25 per cent. above the average, and works should be at hand to supply 75 gallons per capita daily.

With a city growing as rapidly as Winnipeg, it is hardly worth while to build works to supply less than 200,000 people, and it should be assumed that when this population is reached it will all be supplied with city water. The works must, therefore, be able to supply fifteen million gallons of water per day at times when the requirements are greatest, and such works will be suitable for maintaining the supply until the average use throughout the year reaches twelve million gallons daily.

Pipe lines and reservoirs should be supplied at once suitable for this capacity, but low lift pumps, filters, softening plants, etc, which can be added in units, may be provided now of somewhat smaller capacity, but so designed as to be capable of ready extension to this limit. With reference to the further development of the city, the source of the water supply should, if possible, be capable of development to a much larger capacity.

The final pumps and the pipes leading to the city must have a greater capacity than this. In general these pipes should be capable of carrying water at three times the annual average rate of consumption. The maximum ordinary rate of consumption is about twice the annual average rate, and, in addition to this, allowance must be made for fires, making the total allowance as stated. The pipes must be capable of carrying a very large quantity of water to any point where a large fire may occur, in addition to the ordinary quantity of water taken by consumers. With the main pumping station at its present location, a new 36 inch pipe to Main street in addition to the pipes now in place would seem reasonable, followed by other pipes north and south, connecting with the pipe system until water for fire service can be concentrated wherever required.

Pumps will be required with a combined capacity of at least thirty-six million gallons per day, including those now in service and those ordered, so far as available for fire service in the completed system, and at least half of this pumping capacity should be made available at the earliest possible date. The pumps should always be capable of meeting all ordinary conditions of services with one pump idle.

A pure water reservoir should be provided so that the purification works and other parts of collection system can be operated at a uniform rate throughout the 24 hours. The pure water reservoir will hold the excess of water during the night, and make it available during those hours of the day when the consumption is above the average. It will also provide a supply of water immediately available in case of fire. The pure water reservoir should have a capacity equal to half the average daily supply, of six million gallons, and it must be covered to protect, it from ice in winter, and to prevent the deterioration in quality in summer, which comes from the growth of vegetable organism in clear water when exposed to sunlight.

In case a separate high pressure water supply for fire service should be installed taking water from the Red river and reaching those parts of the city where the largest buildings are located, it would be possible to reduce somewhat the size of the works for the final pumping and distribution, making them large enough to supply water equal to twice the annual average rate, with a reserve of one pumping unit above this capacity. The size of the preliminary works would not be changed, as it would not affect materially the average quantity required.

The sizes thus arrived at, agree substantially with Mr. Hering's conclusions, for he thought, eight years ago, that 2,400,000 gallons per day or 60 gallons per capita for a population of 40,000 should be immediately available, and that pipe lines, etc., should be capable of suppling 6,000,000 gallons daily. In other words the supply was to be selected and designed with reference to that quantity. The requirements are now fully two and a half times as great, and no supply should be now considered with a capacity of less than 15,000,000 gallons daily, while the capacity of the works immediately required may be taken as 6,000,000 gallons, with a likelihood that the rapid growth of the city will exceed this capacity before the new works can be built.

Source of Supply.

The possible sources of supply which seem most promising are:

Artesian wells with softening.

Poplar Springs.

Assiniboine river water with filtration.

Red river water with filtration.

Winnipeg river water with filtration.

I have made certain computations regarding these sources of supply, based upon maps and elevations furnished by Col. Ruttan, and upon analysis of samples of water contained in Mr. Hering's report, and furnished by the officers of the Canadian Pacific railroad, and such other information as could be secured.

The waters at Winnipeg are, in general, very hard. The softest water is that of the Red River. The present water supply obtained from wells is softened at very considerable expense, and apparently it would be necessary to soften water from any source near at hand to make it acceptable.

The water from Poplar Springs, 18 miles to the north, is much softer than the well water now used, in fact it is as soft as that water after treatment. The water of the Winnipeg river, 55 miles to the eastward, is still softer, softer in fact than could be obtained by any chemical treatment of the local water.

If the city required thirty or forty million gallons of water per day, it would be cheaper to pump water from the Winnipeg river, through a pipe line fifty-five miles long, and to filter it to remove vegetable matter, than to soften the local water, but the relative cost of the pipe line in comparison with the cost of softening is much greater in a smaller supply, and it will not pay to go so far for the quantity now required.

For a supply of fifteen million gallons per day a 48 inch riveted steel pipe line would be required, costing with the required pumps and filters about five million dollars. Half a million of this for pumps and filters could be deferred for a few years.

It may be that a wood stave pipe could be substituted for the steel at less expense, and that it would last well in this climate, but even if this should prove to be so, the cost would probably exceed the financial ability of the city at this time.

The Poplar Spring water is as soft as the present supply after softening, and if the quantity is sufficient it could be brought eighteen miles for less than the cost of operating a softening plant with the local water. If there is plenty of water easily obtainable of the quality shown by the analysis, it would be a better source of supply than the present well.

The works would cost about two million dollars (without softening of which half a million could be postponed for a few years, leaving a present cost of one and a half millions. If enough water is there, the project is an attractive one, but it should not be considered unless it is perfectly certain that fifteen million gallons per day will be readily available in a dry time.

The Present Source of Supply.

The present source of supply is from a well in the limestone rock. A second well has recently been excavated about 200 feet from it. This well will be put in service as soon as the new pumps are ready.

Over the limestone rock there is a layer of mixed gravel, and above this there is close-grained imprevious clay, extending nearly to the surface of the ground. In this clay, at intervals, there are streaks of sand. I was unable to see the rock at the wells, but it is exposed in the city quarry, some miles away, and I understand that the formation is the same as that in which the wells are situated.

The bulk of water clearly is obtained from passages in the limestone rock, and not from the gravel over the rock. The gravel no doubt yields water freely, but its carrying capacity is not sufficient to allow the flow of a considerable quantity of water for long distances through it.

The limestone rock, as shown at the city quarry, is close-grained, and the seams in it are not large. No large quantity of water could flow through the body of this rock, or the ordinary seams. At one place in the city quarry, a hole in the rock of considerable size is exposed. The workmen say that this is part of a continuous passage under the quarry. When drilling over it, the drill will drop about five feet when this opening is reached. Passages of this kind are common in limestone rock, and the general movement of water must be in channels of this kind.

The success of a particular well in obtaining a large supply of water depends upon hitting one of these cavaties. Evidently, from the freedom with which water enters the well now supplying the City, channels of adequate capacity were encountered. The new well is apparenfly connected with the same channels, because air under pressure forces its way through to the old well.

The old well also serves to lower the general ground water-level, as shown by wells reaching the limestone rock, over a large area, indicating that the channels in the rock have free connections for corresponding distances.

The new well will allow water to be taken at a lower level than in the present well, and will, therefore, draw water from a somewhat greater distance, and will increase the amount of water which can be secured. It does not seem possible that any new source of supply will be encountered, and the increase in capacity over that obtainable from the present well will probably be limited.

If more water of the same character is to be secured, it would seem necessary to put down another well outside of the area in which the ground water level is now lowered by the present well and where water would be drawn from an entirely independent source of supply.

Test wells would be required to determine just where this would be. Probably, it would be necessary to go a mile or more from the present wells, and a separate pumping station would have to be built in connection with the new source.

The well water, as now obtained, is very hard, and the hardness is of such character that it is more than ordinarily difficult to remove it.

This is (1) because the ratio of magnesia to lime is higher than usual, and it is more difficult to remove magnesia than to remove lime; and (2) because an unusually large proportion of the lime and magnesia are present as chlorides and sulphates, and it is more difficult to remove these than the carbonates, which constitute the greater part of the hardness of many waters. In fact, with the present treatment, the chlorides and sulphates commonly known as "incrusting constituents" are not removed at all, and the total hardness is reduced by less than one-half.

The cost of softening is also much higher than it would otherwise be, because of the very high price which must be paid for lime of sufficient purity to be satisfactory.

In addition to the hardening constituents, the well water contains a very considerable amount of saline matter. This is not particularly objectionable for most purposes, but it gives the water a little taste, and is somewhat undesirable in water used for boiler purposes.

There has been considerable speculation as to the source of the well water. Mr. Hering, in his report, assumes that it comes from the west, Col. Ruttan has spoken of the theory that it comes from the north, from a relatively barren tract west of Lake Winnipeg. If this were so, the water on its way to Winnipeg, would come by Poplar Springs, and presumably, the Poplar Springs water would be from the same source. The analyses indicate clearly that this is not the case. The water drawn from the city well has ten times as much saline matter as the water of Poplar Springs, and a very much larger quantity of encrusting constituents. It does not seem possible that water could change so radically in its character in flowing this additional distance, and it is therefore probable that the waters are from different sources.

Maps on which Col. Ruttan has shown the elevations of water in various wells throughout, and near the city, indicate that the level of ground water gradually drops to the level of the rivers. In other words, it appears that the ground water is flowing through the limestone to both the Red and Assiniboine rivers, and propably from both directions.

I am rather inclined to think that the water does not come from any very distant source, but that it enters the limestone through the gravel above it, and through the sand layers occasionally found in the clay, and at any points where clay does not fully cover the rock and gravel. For instance, near the city quarry, there are obvious opportunities for rain water to enter the limestone rock, and it is very likely that there are other opportunities here and there, and that the fissures in the rock are filled in this way.

Quantity of Water Which Can be Taken from Wells.

I think there is no doubt that a sufficient quantity of water can be obtained from wells in the limestone rock, but it will probably be necessary to put down separate works at considerable distances from each other, to secure enough water to supply the city for a long period, and separate pumping stations will be required in connection with them.

The cost of construction and operation would be relatively high, and will be higher as the quantity obtained from each plant is less, and as the number of plants, to secure a given quantity, is increased.

On the Use of River Waters.

It would be possible to use water from either the Red river or the Assiniboine river with filtration, either with or without softening.

The Assiniboine river could be used more conveniently in connecn with the existing works, but the Red river water is softer, and probably could be more cheaply treated, and it would probably be softer and freer from saline matters after treatment.

The Red river about Winnipeg has a drainage area of about 46,000 square miles, and the population upon it in 1900-1901 was 459,000, or ten per square mile. There were four towns with populations of over 4,000 each, and 30 smaller villages, having altogether a population of 74,000.

The Assiniboine river has a drainage area of 58,000 square miles, but it comes from a dryer country, and the flow of the river is less than the flow of the Red river. The total population on watershed in 1900-1901 was 152,000, or which 10,544 were in three towns, the largest being Brandon. The total population per square mile was less than three.

The population upon these rivers will drobably increase rapidly, and the towns will grow in number and in size. Nevertheless, the population upon the watersheds and the pollution of the waters by sewage are very small indeed in comparison with those of many rivers in the eastern part of the United States and in Europe, which have been successfully used after purification by filtration.

At the present time (Feb. 17) the waters of both the rivers are clear, but at times they are said to become quite turbid. There are no records to show the amounts of suspended matter which they sometimes carry, and it is impossible, in the absence of this information, to tell with certainty just what appliances would be required to properly purify them.

It is safe to assume, however, that the sediment carried would not be greater in amount nor more difficult to remove than that of many rivers which have been successfully treated, and the waters of these rivers or either of them can be successfully purified to remove the sediment, and the effects of sewage pollution, and, if desired, the hardness of the water can be reduced. It is therefore possible to obtain from them water which would be entirely satisfactory for every purpose of a municipal supply.

I believe it would be possible to construct purification works capable of softening well water, and also capable of purifying river water; and so that they would be well adapted to either service. Wells could therefore be located near the banks of one of the rivers above Winnipeg, and well water obtained from them, and softened. If the supply of well water fell below the requirements, the shortage could be made up with river water, and a plant so arranged would be sure to always furnish water, and would be free from the risk of a well water plant away from any other source.

Suggested Arrangement of Works.

If Assiniboine river is used, I would urge that the intake should be placed at some distance up stream. The city is sure to grow, and it will save a great deal of trouble in future years to have the intake beyond the area which will be built up in a considerable period

I would suggest going above Sturgeon creek at St. Charles. The pumping station at this point would lift water to a purification plant nearby, or the water could be pumped through a 42 inch rivetted steel pipe to purification works located near the present pumping station. The latter arrangement would have the advantage of centralizing the works at one point, except for the preliminary pumping station. A test well might be put down at this point, and if the indications were favorable, a large well could be sunk, and as much water secured from this well as possible, and the river only resorted to, after the wells failed to meet the demands.

It may be that the suggested site is not particularly promising place for a well in the rock. Certainly the ground water level in the vicinity would be lower than at a distance from it. Nevertheless pumps would be installed to take water below the river level, and arranged in this way I think there is no evidence that the yield would not be as free as from a point where the original ground water level was higher.

The wells of the Canadian Pacific railway to the westward, yield water as freely as at Winnipeg. Aside from this question, I think the water of the Assiniboine could probably be softened and filtered at less cost than the well water, because less chemicals would be required, and the water produced might be fully as good.

The approximate cost of building a pumping station at this site and a purification plant complete, and a 42-inch rivetted steel pipe to the present works, a covered filtered water reservoir, and the required high lift pumps would be approximately $1,500,000. Of this work, the construction of the pumps and filters, costing about half a million dollars, could be deferred for a few years, so that the present cost of the works for a supply of this kind would be approximately $1,000,000.

If the Red river should be selected in preference to the Assiniboine, because its water is softer and contains less saline matter, the works could best be located on the west bank of the river, well above the city, probably in the parish of St. Vital. It probably would not be advisable to connect these works with the existing works in any way. An entirely independent plant would be provided, pumping water, however, into the present pipes in the city but from another direction.

There would be some advantages and some disadvantages in this. The disadvantage would consist in the greater cost of operation, from the separation of the works into two parts.

On the other hand, the pumps lifting the water from the river to the purification works and those pumping the purified water to the city, could be placed in one building, and the operation of the filters could be controlled from the same point.

The cost of a complete plant built in this way probably would not differ greatly from the cost of the plant to use Assiniboine water in connection with the present works.

The cost of securing supplies from the various sources, estimated very roughly from the best data now at my disposal, and with the works in all cases of the capacities indicated above, are as follows:

(1) One-half pumps and filters installed, all other parts built for full quantity.

Six million gallons of water used daily as annual average.

	First Cost of Works.	Interest and Sinking Fund Payment 5 p.c.	Operating Expenses including Pumping to City	Total Annual Cost of Supply.
Winnipeg River filtered	[illegible]	[illegible]	[illegible]	[illegible]
Poplar Springs not treated	[illegible]	[illegible]	[illegible]	[illegible]
River water filtered in connection with present works	[illegible]	[illegible]	[illegible]	120,000
River water filtered and softened	[illegible]	[illegible]	[illegible]	[illegible]

(2) Works completed to full capacity.

Twelve million gallons of water used daily as annual average.

	First Cost of Works.	Interest and Sinking Fund Payment 5 p.c.	Operating Expenses including Pumping to City	Total Annual Cost of Supply.
Winnipeg River filter	$3,000,000	[illegible]	[illegible]	[illegible]
Poplar Springs not treated	2,000,000	100,000	70,000	170,000
River water filtered in connection with present works	1,500,000	75,000	90,000	165,000
River water filtered and softened	1,500,000	75,000	125,000	200,000

The estimate for Poplar Springs is made on the assumption that water can be easily obtained, and does not imply that that is the case, for the information at hand is not sufficient to determine this point. No estimate is made of the cost of continuing the well water supply with softening, owing to lack of information as to how far it would be necessary to go, and how many works it would be necessary to build to secure enough water. In any case the cost would probably equal, or exceed, the cost of river water, filtered and softened.

The data at hand are not sufficient to determine which is the best source of supply for you to adopt. I present the matter to you for discussion, and with the most earnest recommendation that the matter of deciding upon, and securing an additional supply, be pushed.

In my judgment, nothing is more essential to the welfare of your city than plenty of good water. The Assiniboine water has played only a minor part in the recent outbreak of typhoid fever. Nevertheless, a good and ample water supply will do much to improve sanitary conditions, and it is an essential part of what must be done to protect the city from this disease in future.

Respectfully Submitted

(Signed) ALLEN HAZEN.

Winnipeg, Feb. 20, 1905.

Approximate Estimates of Cost.

(1) WINNIPEG RIVER—

COST OF CONSTRUCTION.

Intake and pumping station at Winnipeg River, 4 pumps each capable of lifting 6,000,000 gallons per day 120 feet high, complete	$ 250,000
85 miles 48 inch rivetted steel pipe capable of carrying 16,000,000 gallons per day.	3,410,000
Purification works, located either upon the height of land or at Winnipeg, capable of treating all the water that will go through the pipe line with reserve units in addition	400,000
Covered pure water reservoir, at Winnipeg, holding six million gallons	80,000
High lift pumps, 5, each capable of pumping 6,000,000 gallons per day (in addition to present works) with boilers, house and piping complete	340,000
Sum	$4,480,000
Add 15 per cent. for engineering and contingencies	670,000
Total estimated cost of construction	$5,150,000

COST OF OPERATION.

	Per 1,000,000 Gals.
Preliminary pumping, average lift 100 ft. at Winnipeg River	$ 6.00
Operating filters (an easy water to treat)	3.00
High lift pumping at Winnipeg	11.00
Total cost	$20.00
Cost per annum 20x12x365	$88,000

Smaller quantities would cost somewhat more in proportion.

(2) POPLAR SPRINGS—

COST OF CONSTRUCTION.

Works for collecting water	$ 100,000
Pumping station at source, 4 pumps each 6,000,000 gallons daily capacity, with boilers, house, etc., complete	250,000
75 miles of 42-inch rivetted steel pipe (a little smaller than from Winnipeg river because more head can be used up in friction)	950,000
Covered six million gallon reservoir	80,000
High lift pumps as above	340,000
Sum	$1,720,000
Add 15 per cent. for engineering and contingencies	258,000
Total estimated cost	$1,978,000

COST OF OPERATION.

	Per million gals.
Pumping at source to city to overcome friction and suction from wells	$ 6.00
High lift pumping at Winnipeg	11.00
Total cost	$ 17.00
Cost per annum 17x12x365	$75,000

Smaller quantities would cost somewhat more in proportion.

(3) RIVER WATER IN CONNECTION WITH EXISTING OR ADDITIONAL WELLS

(This estimate applies substantially to either the Red or the Assiniboine rivers.)

COST OF CONSTRUCTION.

Intake and pumping station complete with four pumps, each capable of lifting six million gallons of water per day to a height of 50 feet	$ 187,000
Pipe line of rivetted steel pipe, 42 inches in diameter, and of an assumed length from the intake to the city of 6 miles	317,000
Purification works suitable for filtering and softening river or well water, or mixture	400,000
Pure water reservoir, Covered, 6,000,000 gallon capacity	80,000
High lift pumping station as above	330,000
Sum	$1,314,000
Add fifteen per cent. for engineering and contingencies	201,000
Total estimated cost	$1,515,000

COST OF OPERATION.

	Per million gallons.
Filtering without softening river water, pumping from river to purification works, 20 ft. lift	$ 4.00
Operating filters with chemical treatment to remove turbidity, and the effects of sewage pollution	7.00
High lift pumping to city	11.00
Total cost without softening	$22.00
Additional cost if the water is softened	17.00
Total cost with softening	$ 40.00

ANNUAL COST.

Without softening 22x12x365	$ 100,000
With softening 40x12x365	175,000

Smaller quantities would cost somewhat more in proportion.